USDA United States Department of Agriculture

Forest Service

Northeastern Research Station

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Northeastern Research Station

Celebrates 75th Anniversary


NORTHEASTERN RESEARCH STATION
NE
PROTECTING
UNDERSTANDING
UTILIZING
MANAGING

The USDA Forest Service's Northeastern Research Station (formerly known as the Northeastern Forest Experiment Station) began in June 1923 in Amherst, Massachusetts, with a small group of scientists. The private landowners of the Northeast (particularly small farmers with woodlots) needed solutions to their forestry problems. The U.S. Government, through the Department of Agriculture's Forest Service, took on the research to help these forest-landowners and Congress authorized the establishment of the Station. At that time it included New York and New England, but since then, the Station's domain has been expanded to include New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, and Ohio as well.

Currently, 61 percent (93.3 million acres) of the total land area in the 13 states making up the Station's domain is forested, with 78.9 million acres in private ownership. Of the 2.5 million private forest owners in the Northeast, about half own less than 10 acres and 8,000 are industrial. To serve the people and forests of these states, the Northeastern Research Station has 10 field locations in 8 states (see map on page 25); each location has at least1 research work unit (RWU) or as many as 3. Each of the 21 RWU's has a specific mission, along with related projects. The Station has a total of about 104 scientists, 136 technicians, and 79 administrative personnel. Many of the scientists do field research on the 8 experimental forests (see page 24) and 6 research natural areas (see page 25) found throughout the Northeast. These experimental forests were established, beginning in the 1920's, in all of the Northeast's principal forest cover types. The records kept at the older of these experimental forests are invaluable benchmarks in current global climate change studies.

The NE Station's research is focused on the following areas:

- Maximizing forest values to people and their environment
- Developing the recreation potential of forests
- Solving forest insect and disease problems
- Improving forest watershed and wildlife habitat management

- Upgrading forest commodities
- Expanding forest products markets

For general information about Station programs, activities, and research findings, please contact the Communications Section, USDA Forest Service, 100 Matsonford Road, 5 Radnor Corporate Center, Suite 200, Radnor, PA 19087-4585; tel: 610-975-4112; e-mail: dmcgee/ne@fs.fed.us.

CONNECTICUT
Hamden

The Role of Forest Insect Biology and Biocontrol in Maintaining Forest Health

Native forest insects can have both beneficial and negative effects on the health of forest ecosystems. However, accidental introduction of exotic species often results in significant negative impacts, primarily because the natural controls associated with these species are absent in their new habitats. The accidental introductions of exotic insects such as the gypsy moth and the hemlock woolly adelgid have already caused major changes in the health and composition of the forests of North America. Because the introduction rate continues to accelerate—largely due to increased international trade and commerce, expanded tourism, and immigration—exotic insects continue to pose threats to northeastern forests. These threats include the risk of introductions of new exotic pests; continuing outbreaks and spread of established and native pests; aggravation of the severity of insect pest outbreaks due to interaction with chronic and acute abiotic stressors or other disturbance agents; and lack of effective management strategies to reduce the impact of insect pests.

Scientists in this unit are focusing their research on the biology and ecology of native and exotic insect pests and their biological control. The successful response to the Asian gypsy moth and recently initiated research on the hemlock woolly adelgid have emphasized the need for (1) increasing basic knowledge of the interactions of

insects with their natural enemies, host plants, and environmental stressors and (2) developing methods to prevent establishment of exotic forest insect pests before they cause changes in the health and composition of our forests. Effective methods for biological control of insect pests are in increasing demand due to public concern about the use of conventional pesticides, increasing incidence of pesticide resistance, and the continually emerging threat of exotic invaders. The long-range goal of this unit's research is to understand the role that insects have in maintaining healthy forest ecosystems and to improve the sustainability of forest ecosystems by mitigating the effects of insects that impact forest health.

For more information, contact Kathleen Shields, project leader, USDA Forest Service, Northeastern Research Station, Northeastern Center for Forest Health Research, 51 Mill Pond Road, Hamden, CT 06514-1703; tel: 203-230-4330; e-mail: kshields/ne_ha@fs.fed.us.

Pathology and Microbial Control of Insects That Impact the Health of Eastern Forests

Eastern hardwood forests are frequently under attack by several species of tree-defoliating insects and are threatened by introductions of non-indigenous species. In response to these threats, scientists on this research team are developing and improving environmentally acceptable microbial pesticides that forest and urban managers can recommend in order to prevent damage and associated impacts caused by pests such as the gypsy moth and brown-tail moth.

Primary efforts are directed at improving the performance of commercial formulations of Bt (*Bacillus thuringiensis*) and the gypsy moth viral pesticide GYPCHEK®, determining which mixture of Bt toxins is most effective against specific native and exotic forest defoliators, and evaluating the effects of Bt applications on non-target forest butterflies and moths (that is, Lepidoptera).

Researchers are placing increased emphasis on identifying native and exotic pathogens of

forest insect pests such as viruses, fungi, and microsporidia (protozoa); evaluating their potential use as classical biological control agents; and devising strategies for their introduction or application.

For more information, contact Michael L. McManus, project leader, USDA Forest Service, Northeastern Research Station, Northeastern Center for Forest Health Research, 51 Mill Pond Road, Hamden, CT 06514-1703; tel: 203-230-4322; e-mail: mmcmanus/ne_ha@fs.fed.us.

Disturbance of Eastern Forest Ecosystems by Stressor/Host/ Pathogen Interactions

Stress-induced diseases are major disturbances affecting the health of northeastern forests. Nowhere are the complicated dynamics of forest health and forest ecological processes more evident than in the research underway to determine how stressors, hosts, and pathogens interact to disturb forests and how such disturbances affect forest and ecosystem structure, function, and sustainability.

Researchers in this group—co-located at Hamden, Connecticut, and Durham, New Hampshire—have expertise in plant pathology, plant ecology, plant physiology, biochemistry, microbiology, and soil science. A major focus of their research will determine the mechanisms by which atmospheric deposition affects tree and forest health. Understanding these relationships will enable scientists and eventually practitioners to determine what forests or portions of forests are susceptible and vulnerable to this stress and subsequent diseases, and to develop methods and procedures to measure, predict, and mitigate disease before or when it occurs.

Major goals of the group's research, which ties in closely to ecosystem management, are to develop an understanding of the interplay between ecological processes and the onset and development of stress-induced diseases; to develop indicators of stress and susceptibility and vulnerability to disturbance from it; to clarify the relationship of disturbance caused by these diseases to forest health and the ability of the ecosystem to supply a variety of goods, services, and ameni-

ties in a sustainable manner; and to create guidelines for managing these diseases.

For more information, contact Philip M. Wargo, project leader, USDA Forest Service, Northeastern Research Station, Northeastern Center for Forest Health Research, 51 Mill Pond Road, Hamden, CT 06514-1703; tel: 203-230-4304; e-mail: pwargo/ne_ha@fs.fed.us.

Massachusetts
Amherst

Wildlife and Fish Habitat Relationships in New England Forests

Researchers at the wildlife habitat unit in Amherst are working in four areas: vegetation structure and forest wildlife distribution, Atlantic salmon habitat research, acorn production and ecosystem dynamics, and the ecology of seasonal forest ponds. The arrangement of forest stands of various types, ages, and extent on the landscape and the mix of live and dead trees within stands largely determine the wildlife species that can exist in the landscape and the forest. Unit scientists are working to identify configurations of forest vegetation that optimize wildlife habitat in New England forests.

Atlantic salmon are anadromous fish that spawn in small tributaries of New England rivers. Salmon were historically abundant in most major New England rivers before dams and development seriously reduced their populations. The unit's scientists are working to identify biotic and abiotic factors that affect the growth and survival of young Atlantic salmon, thus aiding efforts to re-establish self-sustaining populations.

Forest management practices and acorn production each drive complex webs of interactions among wildlife abundance, tree regeneration, and forest health. Understanding these interactions will help biologists and forest managers regenerate and sustain oak forests and their associated wildlife communities.

Seasonal forest ponds, or "vernal" ponds, are critical breeding and/or foraging habitat for several amphibian species and a rich macroinvertebrate community. Scientists at Amherst will assess the ecology of these important

habitats, the hydrologic relationships of the ponds and their forest catchments, and the role of forest history in the composition of pond fauna.

Research at the Amherst unit is directed at helping us better understand the relationships between habitat and wildlife populations in New England forests.

For more information, contact Richard M. DeGraaf, project leader, USDA Forest Service, Northeastern Research Station, University of Massachusetts, Holdsworth Hall, P.O. Box 34230, Amherst, MA 01003-4230; tel: 413-545-0357; e-mail: rdegraaf/ne_am@fs.fed.us.

New Hampshire
Durham

Measurement, Analysis, and Modeling of Forest Ecosystems in a Changing Environment

In order to estimate the effects of such problems as air pollution or pest attack and to model future environmental changes, scientists need survey and sampling techniques to determine "normal" historical growth and yield of trees and stands. Scientists in this unit are developing methodologies for statistical and process modeling that can be used by forest managers and other researchers. Enhanced computer models will quantify response to a range of forest management practices in terms of tree growth and reproduction, wildlife habitat characteristics, measures of diversity, and other forest values.

For more information, contact Dale S. Solomon, project leader, USDA Forest Service, Northeastern Research Station, Louis C. Wyman Forestry Sciences Laboratory, P.O. Box 640, Durham, NH 03824-8640; tel: 603-868-7666; e-mail: dsolomon/ne_du@fs.fed.us.

Ecology and Management of Northern Forest Ecosystems

The northern forest is a complex mixture of temperate and boreal species of plants and ani-

mals. Its location near the largest concentration of people in North America puts great demands on the northern forest for the broad array of values and uses it can provide.

Scientists in this unit are working to provide fundamental scientific information and appropriate practical guidelines needed to manage northern forest ecosystems for both ecologic and economic sustainability. They seek to understand how a range of management activities affect regeneration, composition, structure, growth, and productivity of northern forests. Their research may be conducted on micro-sites or on landscapes; it may focus on forest responses measured in minutes or in decades. The technologies used may be as simple as a ruler or as complicated as the space shuttle. The knowledge gained in this research will help land managers make scientifically based decisions about providing the many values and uses society expects from its forests without harming the long-term health and vigor of those forests.

For more information, contact John Brissette, project leader, USDA Forest Service, Northeastern Research Station, Louis C. Wyman Forestry Sciences Laboratory, P.O. Box 640, Durham, NH 03824-0640; tel: 603-868-7632; e-mail: jbrisset/ne_du@fs.fed.us.

Ecological Processes: A Basis for Managing Forests and Protecting Water Quality in New England

In forests with limited nutrient capital, like much of the forest landscape in New England, the efficient cycling of nutrients between soil, plants, and forest floor is critical to maintaining healthy and productive forests. Acid rain has altered biogeochemical cycling in New England forests by leaching nutrient base cations from the soil and changing nitrogen dynamics. Additionally, the cumulative effects of natural disturbances, past land use, current intensive harvesting practices, and projected future logging can affect available nutrients by removal of nutrients in the harvested biomass and short-term increases in leaching. Aquatic ecosystems are also affected by changes in their terrestrial source areas.

Scientists in this unit are investigating the ecosystem processes and site factors that control susceptibility to changes in nutrient avail-

ability due to the combined effects of acid rain and natural and human-caused disturbances, the effects of these changes on forest health and productivity, and the linkages between changes in the terrestrial ecosystem and associated aquatic ecosystems. Much of the research is centered at the Forest Service's Hubbard Brook Experimental Forest in New Hampshire and involves many cooperating scientists.

For more information, contact Christopher Eagar, project leader, USDA Forest Service, Northeastern Research Station, Louis C. Wyman Forestry Sciences Laboratory, P.O. Box 640, Durham, NH 03824-0640; tel: 603-868-7636; e-mail: ceagar/ne_du@fs.fed.us.

New York
Syracuse

Effects of Urbanization on Forest Ecosystems In and Near Cities

About 80 percent of the U.S. population lives in urban areas, and many of these urban residents are subject to high levels of air pollution, thermal stress, and ultraviolet radiation. Scientists on this research team are seeking to determine optimal arrangements and composition of urban vegetation to enhance human and environmental health and well-being in urban areas.

These researchers are collecting field data and developing models to quantify pollution removal by trees and other surfaces in cities. They are also building models to assist users in determining their current vegetation composition and its impact on local air quality. Models are also being developed to determine how trees throughout a neighborhood work together to influence microclimate, energy use, and levels of ultraviolet radiation.

In addition, researchers are assessing the specific environmental effects of urbanization and identifying strategies for future development that will have minimal negative impacts on forest ecosystems. Urbanization effects include forest fragmentation, increased wildfire, and changes in hydrologic and nutrient cycles.

For more information, contact David J. Nowak, project leader, USDA Forest Service, Northeastern Research Station, 1100 Irving Avenue, c/o SUNY, 1 Forestry Drive, 5 Moon Library, Syracuse, NY 13210-2778; tel: 315-448-3212; e-mail: dnowak/ne_sy@fs.fed.us.

Ohio
Delaware

Quantitative Methods for Modeling and Monitoring Response of Northeastern Forest Ecosystems to Management and Environmental Stresses

Changes in species distribution due to fire suppression have already been noted in fire-adapted mixed-oak communities. These forest communities are not replacing themselves now that fires are routinely suppressed. Scientists in this unit are evaluating the effects of prescribed burning on soils, understory plants, trees, insects, and birds in this highly integrated study to see if these communities can be restored.

Additionally, shifts in species distributions might result from global climate change. Computer simulation models of tree regeneration, growth and development, migration, and climate/land/vegetation models are being developed to produce maps that will provide insights into the implications for our current eastern species.

Scientists in this group are modeling and monitoring forest plant community responses to management and environmental stresses at the stand, forest, and landscape scales. First, they develop improved methods of modeling natural communities and their responses to ecosystem management practices and other disturbances. Second, they study ecosystem management practices for mixed-oak forests that meet the public's demand for sustainability, biodiversity, and animal habitat while still providing timber products. Third, they design integrated methods of monitoring the responses of forest ecosystems to promote sustainability and to improve scientific understanding.

For more information, contact Charles T. Scott, project leader, USDA Forest Service, Northeastern Research Station, 359 Main Road, Delaware, OH 43015-8640; tel: 740-368-0101; e-mail: cscott/ne_de@fs.fed.us.

Development of Biologically Based Controls for Forest Insect Pests and Diseases Through Molecular Technologies

Insects and diseases cause more than one billion dollars of damage annually to our nation's forests. Biological control agents and biologically based control strategies (called "biorational approaches") offer a timely approach for control of both forest insect pests and diseases in the context of current multiple use demands on our nation's forests and a heightened level of public interest in preservation of the environment.

This research group's scientists and staff are using biotechnology to improve gypsy moth microbial control agents (the gypsy moth virus and *Bacillus thuringiensis*, or Bt); to develop ecto-

mycorrhizal fungi for controlling root-feeding insect pests and for improving tree growth; and to characterize tree defense mechanisms that respond to Dutch elm disease and tree stressors. These research and development efforts will lead to new and/or improved methods for controlling forest insect pests and diseases in an ecologically friendly manner.

For more information, contact James M. Slavicek, project leader, USDA Forest Service, Northeastern Research Station, 359 Main Road, Delaware, OH 43015-8640; tel: 740-368-0033; e-mail: jslavice/ne_de@fs.fed.us.

Multiple Stress Interactions and Their Effects on Forest Health and Sustainability

Eastern forests are exposed to a wide range of stressors, including drought, defoliation, disease, atmospheric deposition, and air pollution. These stressors interact to affect tree and forest health. Projected increases of atmospheric carbon

dioxide and global climate change may also affect these interactions.

The scientists on this research team work to understand how these stressors interact and to provide forest managers with tools to mitigate stressor effects and to sustain forest health and productivity.

Major efforts are directed at determining the effects of elevated carbon dioxide and ozone on the growth and physiology of yellow-poplar and eastern white pine. An important component of this and related research is to develop methods to apply the results of studies on seedlings and saplings to assess stressor impacts on mature trees and forests.

Research focused on understanding the causal factors associated with sugar maple decline on the unglaciated Allegheny Plateau in Pennsylvania is examining the importance of defoliation, stand management, soil and foliar chemistry, and potentially toxic manganese and aluminum cations on sugar maple health. Results of this research will be used to provide managers with guidelines about where on the landscape to grow sugar maple and how to maintain vigorous and diverse forests.

For more information, contact Robert P. Long, project leader, USDA Forest Service, Northeastern Research Station, 359 Main Road, Delaware, OH 43015-8640; tel: 740-368-0050; e-mail: rlong/ne_de@fs.fed.us.

Pennsylvania
Radnor

Forest Inventory and Analysis

Because our forests are renewable resources, they can be managed in many ways to meet current needs and those of future generations. Congress has passed a series of laws to make certain that we have the information necessary for making wise decisions about forest management. The USDA Forest Service is responsible for obtaining this information, and it has set up forest inventory and analysis units in each of its research stations nationwide.

The researchers and economists in this unit at Radnor are responsible for determining a

wide range of information on the 93 million acres of forested land in 13 states of the Northeast. They work to inventory all forest lands, whether private, public, or industrial, through field visits and remote sensing. They take more than 75 different measurements, including land use; forest type; stand size, age, and origin; site class; slope and aspect; soil profile; and water. They also obtain information from all forest industries located in the Northeast, such as sources and amounts of wood used; products; and amounts of residues produced. Forest fragmentation and urban forests, as well as forest health, sustainability, and diversity are additional topics of the unit and its cooperators.

The information is analyzed and presented in several forms: statewide statistical reports as well as special analyses and reports on timber products, forest ownership, forest biomass, wildlife habitat, and ecosystem-related issues. These are presented in databases, CD-ROMs, internet websites, and traditional print media such as scientific journals and natural resource periodicals.

For more information, contact John R. Peters, project leader, USDA Forest Service, Northeastern Research Station, 100 Matsonford Road, 5 Radnor Corporate Center, Suite 200, Radnor, PA 19087-4585; tel: 610-975-4054; e-mail: jpeters/ne@fs.fed.us.

Forest Health Monitoring and Research Quality Management

The Forest Health Monitoring (FHM) Program was established in 1990 in response to concerns about air pollution, acid rain, global climate change, population growth, and sustainable forestry, and their effects on forest ecosystem health. State and federal agencies have agreed to work together to develop a program for monitoring and reporting the health of the nation's forest. Each year, the FHM program reports on the following indicators of forest health (taken from plot data): crown and damage assessments, bio-indicator plant condition, lichen abundance, and soil properties. These reports also include other

factors affecting forest health, including insect and disease conditions and weather-related information (taken from surveys and other sources).

The USDA Forest Service is known for its top-quality research. However, our methods, results and credibility are constantly challenged in a variety of venues. We can take full advantage of the knowledge in the field of quality management as it relates to research and development. The integration of modern quality management principles makes our research and researchers more competitive and credible, both within our scientific fields and with the general public. Through the Research Quality Management Program, the Forest Monitoring staff's biometrician and quality-assurance specialist works with scientists, technicians, and management to continually improve and document the quality of the research at the Station.

For more information, contact Charles Barnett, acting FHM program coordinator, USDA Forest Service, Northeastern Research Station, 100 Matsonford Road, 5 Radnor Corporate Center, Suite 200, Radnor, PA 19087-4585; tel: 610-975-4031; e-mail: cbarnett/ne@fs.fed.us.

Northern Global Change Program

In order to address the national issues posed by the White House relating to global change, the Northern Global Change Program focuses research on answering a number of important questions about the effects of global change on forest health and the productivity of forest lands: What is the condition of the forest resource today (current stresses)? What additional effects does climate change pose for the resource? What resources (and where) are most vulnerable to a climate changed world? What socioeconomic impacts might ensue? What options for managing impacted natural resources should be implemented?

The Northern Global Change Program in Radnor has identified these major global change research priorities for the Northeast: forest–atmosphere interactions, physiological response to atmospheric change and multiple stress; nutrient cycling and hydrologic response to acidic deposition; ecosystem process model development; and regional and national analysis for management and policy.

For more information, contact Richard A. Birdsey, program manager, USDA Forest Service, Northeastern Research Station, 100 Matsonford Road, 5 Radnor Corporate Center, Suite 200, Radnor, PA 19087-4585; tel: 610-975-4092; e-mail rbirdsey/ne@fs.fed.us.

Warren

Understanding and Managing Forest Ecosystems of the Allegheny Plateau Region

Forests of the Allegheny Plateau region of Pennsylvania originated after intensive harvesting between 1890 and 1930. Now these even-aged forests are eagerly sought by timber buyers for their valuable crops of black cherry, red and sugar maple, and other hardwood species. People value the wildlife that finds habitat in these forests, the contributions of these forests to biological diversity, and the recreational opportunities provided by these for viewing or hunting and fishing.

Sustaining all these benefits is a challenge. In particular, white-tailed deer maintained at densities well above those recommended by wildlife and forest managers for more than 70 years in the region have altered plant communities and wildlife habitat. In addition, a recent series of droughts and defoliations have exposed underlying nutrient deficiencies in some forest soils and exacerbated sugar maple health problems.

Scientists in this group are working to solve three problems related to sustainable management of aging second-growth forests heavily affected by white-tailed deer. The first is regeneration and forest renewal, or the process of ensuring that new forests—trees, wildlife species, and other plants—grow after timber harvests and other disturbances. The second is stand dynamics and silviculture, or the process of understanding and managing the changes that happen as a forest ages. Some practices, such as fertilization, may help trees grow too tall for deer browsing, while others, such as thinning among the trees, may help create certain kinds of wildlife habitat or accelerate the growth of valuable timber trees. In the third problem, sugar maple decline, the unit's

scientists are working to understand the complex interactions of soil and site factors, tree and plant species, defoliations, droughts, forest management practices, and pollution that have caused sugar maple trees in the region to die at above-average rates for more than a decade. Through all three problems, scientists work to understand how changes in the plant community affect wildlife communities.

Scientists at the laboratory in Warren work closely with scientists from other NE Station locations and with colleagues at several universities to ensure that results gained from research in Allegheny Plateau forests contributes to regional understanding of sustainable forestry.

For more information, contact Susan L. Stout, project leader, USDA Forest Service, Northeastern Research Station, Forestry Sciences Laboratory, P.O. Box 267, Irvine, PA 16329-0267; tel: 814-563-1047; e-mail: sstout/ne_wa@fs.fed.us.

Vermont
Burlington

The Role of Environmental Stress on Tree Growth and Development

There is increasing evidence that atmospheric pollution and climate change may be negatively affecting the health and productivity of forest trees in the Northeast. Burlington scientists in this research group are evaluating the effects of pollutant additions—including acid precipitation, heavy metals, and nitrogen deposition—on tree health and physiology. Because pollution inputs may occur simultaneously with climate change, researchers are also assessing the effect of combined stresses (such as acid precipitation and abnormal winter temperatures) on physiology and growth. Research results are used by other scientists to model and predict the potential impacts of continued environmental change on forest health and productivity. Results also help policymakers determine the adequacy of current air quality standards.

Research by this group is also directed toward an improved understanding of the basic biology of stress adaptation. Drought is a major stress affecting forest health and productivity, and plants have developed many ways to cope with it. These include improved efficiency of water extraction from soils and transport in plants; improved control of water loss by leaves; and tolerance to or avoidance of the dysfunctions that result from drought. Studies are underway in Vermont forests and the tropics. Tropical forests are studied because the high species diversity there permits a better test of ideas concerning plant adaptation. Adaptive features being studied include hydraulic architecture of shoots and roots and vulnerability to drought-induced embolism in xylem. Companion studies in Vermont allow for the evaluation of plant adaptations to freezing and other stresses that affect northern forests.

For more information, contact Mel T. Tyree, project leader, USDA Forest Service, Northeastern Research Station, George D. Aiken Forestry Sciences Laboratory, P.O. Box 968, Burlington, VT 05402-0968; tel: 802-951-1310; e-mail: mtyree/ne_bu@fs.fed.us.

Integrating the Ecological and Social Dimensions of Forest Ecosystem Management

Natural resource management is a social activity in which people interact with each other and with ecological processes to fulfill social goals. These goals may be diverse, encompassing ecosystem functions, forest products, recreational activities, aesthetic and spiritual qualities, community stability, and cultural and historical values. Whether addressing goals of individual landowners, diverse publics, or broader social interests, natural resource managers must work within the context of complex social and biophysical systems. These systems are dynamic and the goals for which forests are managed continue to change.

Policymakers, forest managers, and diverse publics need better information on the interac-

tions of social and biophysical processes to define and achieve their resource management goals. Scientific approaches to analyzing social systems have great potential to provide this information. However, these concepts and their applications need to be developed and integrated with biophysical information in forms that are useful for resource managers.

Scientists in this unit establish integrated studies examining how people relate to the forests around them and how people affect forests. Their research focuses on social structures and processes, individual values and decisionmaking, direct human/forest interactions, and understanding of management actions and their effects on human values. In addition, they develop computer-based tools and other products that help people understand the trade-offs that must be made when deciding how to manage a forest, whether it is one small private property or a large public forest.

For more information, contact Mark J. Twery, project leader, USDA Forest Service, Northeastern Research Station, George D. Aiken Forestry Sciences Laboratory, P.O. Box 968, Burlington, VT 05402-0968; tel: 802-951-1040; e-mail: mtwery/ne_bu@fs.fed.us.

West Virginia
Morgantown

Disturbance Ecology and Management of Oak-Dominated Forests

The oak-dominated forests of Appalachia are diverse and complex, and land managers must deal increasingly with questions about areas that are defined not only by natural boundaries such as stands, drainages, or watersheds, but also by boundaries based on socio-political aggregations and/or land ownerships. Pressures from a variety of interest groups require consideration of detailed and complex management alternatives.

As introduced pests spread through North America, we need to understand and predict their spread in order to guide management activities. Scientists in this unit are studying ways in which defoliation by gypsy moth and other established exotic organisms interact with other forms of disturbance in influencing forest dynamics, successional patterns, and other ecological processes. They are applying the perspective of landscape ecology to understanding the ecological relationships of gypsy moths, forests, and natural enemies and to develop management programs based on these relationships.

Oak regeneration is complicated by excessive deer populations, gypsy moth defoliation and mortality, oak decline, other insects and pathogens, lack of seed sources, increased interfering plants, lack of fire, and invasive non-indigenous plants. An ecological understanding of these factors on regeneration processes is needed to develop silvicultural treatments for aiding oak regeneration. Research efforts focus on development of regeneration treatments for obtaining adequate advanced regeneration in mature stands; determination of limiting factors and development of treatments to counteract them; and development of rehabilitation treatments for areas where gypsy moth, oak decline, and deer have created regeneration failures or undesirable species conversions. Because most eastern forests are privately owned, oak regeneration treatments need to be cost-effective for the landowner if we want to be successful in maintaining healthy sustainable forests.

Models and other decision-support tools that synthesize and integrate results from studies of disturbance effects and dynamics will be produced. These models will lead to better understanding of risk factors and allow us to develop spread models that can be used to provide risk assessment program and management strategies to mitigate effects of the various factors. Scientists are working on software interfaces that give user-friendly access to the broadest possible audience, providing users with cross-platform access to models, embedded in server-based web browsers, that can also be tailored to the corporate equipment and needs of Forest Service users.

For more information, contact Kurt W. Gottschalk, project leader, USDA Forest Service, Northeastern Research Station, 180 Canfield Street, Morgantown, WV 26505-3101; tel: 304-285-1598; e-mail: kgottsch/ne_mo@fs.fed.us.

Forest Engineering Research: Systems Analysis to Evaluate Alternative Harvesting Strategies

Today's forest managers are challenged to include silvicultural objectives, wildlife objectives, timber-harvesting technology, economics, and multiple-use management objectives in the development and application of forest land management plan.

To provide these managers with the information and planning tools they need, scientists in this research unit are studying effective means to integrate resource protection, wildlife, silviculture, timber harvesting technology, product markets, and economics into a long-term complete systems analysis. Their results will help forest managers to determine costs and benefits from managing both timber and nontimber resources on steep-slope eastern hardwoods sites.

Specifically, these scientists are working to develop expert systems to model the growth, wildlife habitat, silvicultural treatment, and harvesting of specific timber stands over extended time periods. In closely related work, they are evaluating group selection and multi-product harvesting as economically viable means of increasing the utilization of eastern hardwood resources. Analytical tools resulting from this research will facilitate integrated economic analysis of forest management plans with respect to both silvicultural and nontimber resource objectives.

For more information, contact Chris B. LeDoux, project leader, USDA Forest Service, Northeastern Research Station, 180 Canfield Street, Morgantown, WV 26505-3101; tel: 304-285-1572; e-mail: cledoux/ne_mo@fs.fed.us.

Sustainable Forest Ecosystems in the Central Appalachians

In the central Appalachians, there are two general forest ecosystem problems of great concern. The first is the lack of successful natural oak regeneration. The second is the effects of air pollution and other disturbances on forest ecosystems and their management.

Scientists in this unit are involved in ecological research to better understand the structure and function of forest ecosystems, in order to assure sustainable forest management of central Appalachian forests for a variety of goals. Their research is primarily conducted on the Fernow Experimental Forest, a 4,700-acre outdoor laboratory and classroom.

Parsons scientists are studying the disturbance history of these forests and the effects of disturbance on various organisms and ecosystem components and are compiling baseline data on wildlife habitat requirements across spatial scales. Ongoing long-term studies, many of them begun 50 years ago and thus extremely valuable, evaluate forest management techniques and their effects on hydrology, nutrient cycling, stand structure, and wood production.

In new studies, those begun since 1994, Parsons scientists are studying the following topics: long-term productivity of forest ecosystems (harvesting, acidic deposition and base cation depletion); wood utilization and ecosystem management; long-term monitoring of small mammal populations on the Fernow Experimental Forest; patterns of oak regeneration in a central Appalachian forest; monitoring effects of Monongahela National Forest timber sales on sediment and aquatic invertebrates; relationship of fine sediment and aquatic macroinvertebrate communities in Elklick Run, Fernow Experimental Forest. In ongoing studies, large-area comparisons of forest management practices; artificial watershed acidification of several small watersheds at or near the Fernow Experimental Forest; strip selection cuttings in mountainous Appalachian hardwoods; stream discharge of four differ-

ent forest practices; application of the shelterwood system in central Appalachian hardwood stands; crop tree release in mature Appalachian hardwood stands ("two-age management"); converting a hardwood watershed to spruce on quantity and quality of stream discharge; and group selection in Appalachian hardwood forests.

For more information, contact Mary Beth Adams, project leader, USDA Forest Service, Northeastern Research Station, Timber and Watershed Laboratory, P.O. Box 404–Nursery Bottom, Parsons, WV 26287-0404; tel: 304-478-2000; e-mail: madams/r9_monog@fs.fed.us.

Princeton

Efficient Use of the Northern Forest Resource

Conserving the natural resources of the northern forests while sustaining forest-based industries and economies in the rural Northeast may seem almost contradictory goals, but finding solutions to these problems is vital to many communities in the Northeast. New information and technologies—developed through research and development on resource characteristics, forest management practices, and innovative processing technologies and their influence on conversion efficiency in solid wood processing—can help maintain the health of both forests and communities.

One of this work unit's research problem areas represents a new line of research. The scientists will work to determine how wood quality and utilization opportunities are affected by silvicultural systems and forest operations. This information will help forest managers identify viable utilization alternatives for the timber available for harvest now and in the future. Results developed in this problem area also will help the forest industry extend the Northern forest resource through improved conversion of timber to roundwood products.

The unit's scientists will also work to develop more effective production control methods and computer software that enable the forest industry to more efficiently utilize the hardwood resource. More efficient use of wood resources can help forest industries meet the growing demand for wood products, while curbing the growth rate in demand for timber.

An integral part of the research is incorporated into the Technical Resource Center, which serves as a source of information for anyone interested in the secondary processing of hardwoods. The staff of the Center has access to numerous databases on woodworking machinery, current and completed research, and various hardwood markets.

For more information, contact John Baumgras, project leader, USDA Forest Service, Northeastern Research Station, Forestry Sciences Laboratory, 241 Mercer Springs Road, Princeton, WV 24740-9628; tel: 304-431-2720 or 304-285-1575; e-mail: jbaumgra/ne_pr@fs.fed.us.

Economics of Eastern Forest Use

Economic information is vital for wise decisionmaking about our eastern forest resources. Information is needed on all markets for roundwood and on the principal consumers of hardwood lumber and wood fiber on a continuing basis. Resource planners need timely resource inventory and usage drain statistics; policymakers need to know the resources supplies, demands, and economic contributions necessary for developing beneficial and relevant natural resource policies; and resource managers need information in order to implement management strategies that will maximize resource values and uses.

According to their recently developed work plan, scientists in this unit will (1) develop annual estimates of primary and secondary hardwood product production and consumption and (2) identify and analyze economic and other factors or events that are likely to significantly alter wood production and consumption patterns and future trends.

Reducing inefficiency and waste in the allocation of timber and other vital and scarce resources can help us to get more products from our available forest resources. Development of new market-based, value-added products could improve the use of forest resources, help achieve resource management objectives, and/or sustain rural communities. Research in this area may be product, process, site and/or market specific. Taken collec-

tively, research in this area will be of benefit to resource managers, to those living in rural America, and to U.S. manufacturers. Scientists in this group will examine and analyze alternatives (opportunities) for extending and conserving the hardwood resource and improving the efficacy of hardwood forest management, utilization, and rural development initiatives.

Scientists in this work unit will work closely with personnel in Forest Inventory Analysis (FIA), who are charged with conducting timber product output (TPO) assessments in conjunction with forest inventory surveys. The cooperative effort between this unit and the FIA is expected to provide critical insights into the linkages between the resource, products, and their resulting impacts on current resource supply and demand, future demands, implications for forest management and the economic viability of rural communities.

For more information, contact Bruce Hansen, project leader, USDA Forest Service, Northeastern Research Station, Forestry Sciences Laboratory, 241 Mercer Springs Road, Princeton, WV 24740-9628; tel: 304-431-2739; e-mail: bhansen/ne_pr @fs.fed.us.

Enhancing the Performance and Competitiveness of the U.S. Hardwood Industry

Alternative strategies for improving the long-term performance and competitiveness of the U.S. hardwood products industry are much needed for improving the economic health of Northeastern communities. At the same time, maintaining healthy and sustainable forest ecosystems is necessary to any long-term strategy involving use of our natural resources.

Scientists in this unit will be analyzing the structure, conduct, and performance of the various hardwood products industries that utilize hardwood, roundwood, or hardwood timber. This includes determining the number of sellers and buyers in a market, the degree of market concentration, how companies differentiate their product, cost structures, and the degree of integration (the structure); determining pricing, price formation, and price discovery (the conduct); and economic efficiency and social responsiveness (the performance). Structure determines conduct, and conduct determines performance.

Scientists in this unit will also be assessing the effect of an alternative intervention (legislative or administrative actions by federal, state, or local governments that affect a specific industry or group of industries) approach developed to remedy externalities (byproducts of a production process such as pollution or landscape alteration) that result from the production, harvesting, and processing of hardwood timber.

In addition, the unit's scientists will explore strategies that will help hardwood processing firms and industries to remain competitive while following the mandate of a changing society.

For more information, contact William Luppold, project leader, USDA Forest Service, Northeastern Research Station, Forestry Sciences Laboratory, 241 Mercer Springs Road, Princeton, WV 24740; tel: 304-431-2770; e-mail: wluppold/ne_pr@fs.fed.us.

Field Research Sites

The following experimental forests are within the USDA Forest Service's Northeastern Research Station:

- Bartlett Experimental Forest, New Hampshire
- Fernow Experimental Forest, West Virginia
- Hubbard Brook Experimental Forest, New Hampshire
- Kane Experimental Forest, Pennsylvania
- Massabesic Experimental Forest, Maine
- Penobscot Experimental Forest, Maine
- Silas Little Experimental Forest, New Jersey
- Vinton Furnace Experimental Forest and Raccoon Ecological Management Area, Ohio

Northeastern Research Station

The Northeastern Research Station and the Eastern Region (9) of the National Forest System jointly administer the following 6 research natural areas:

- The Bowl, Alpine Gardens, and Nancy Brook Research Natural Areas, White Mountain National Forest, New Hampshire
- Reas Run Research Natural Area, Wayne National Forest, Ohio
- Tionesta Research Natural Area, Allegheny National Forest, Pennsylvania
- The Cape Research Natural Area, Green Mountain National Forest, Vermont

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